TN 23
U595

I. C. 7520

JUNE 1949

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SMALL PORTABLE COAL-DUST EXPLOSION GALLERY

BY

G. W. GROVE AND G. L. FREAS

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SMALL PORTABLE COAL-DUST EXPLOSION GALLERY 1/

By G. W. Grove2/ and G. L. Freas3/

INTRODUCTION

One of the chief hazards in mining bituminous coal is the accumulation of coal dust in the mines. When coal dust is thrown into suspension, it can be ignited and exploded by electricity through short-circuiting of mining machinery and trolley wires, or by arcs and sparks.

The Bureau of Mines has endeavored to assist the coal-mining industry in preventing disasters from this cause by urging that all bituminous-coal mines be rock-dusted. As it has been difficult to convince some mining men of the danger of ignition of coal dust and of the effectiveness of rock dusting in preventing widespread explosions, a small, portable, coal-dust-explosion gallery has been designed to demonstrate the explosibility of bituminous-coal dust. Such galleries are furnished to Bureau engineers, inspectors, and safety instructors to illustrate visually and impressively the Bureau's accident-prevention educational work on the causes and prevention of dust explosions in bituminous-coal mines.

DESCRIPTION AND OPERATION OF GALLERY

Figure 1 shows the gallery and specially designed accessories compactly housed in a wooden carrying case 7 by 13-1/2 by 11-1/2 inches and weighing 21 pounds. The case is convenient to carry and contains everything needed to give a convincing demonstration anywhere where a 110- or 115-volt a.c. electrical outlet is available. (The voltage is reduced to 24 volts a.c. by a transformer under the gallery panel.) The gallery can be assembled in a few minutes, and coal dust will not be dispersed into the atmosphere after the demonstration.

Figure 2 shows the gallery assembled. The accessories are shown in the foreground and, from left to right, consist of jars for dust samples, electrical plug and cord, mortar and pestle for pulverizing coal, measuring spoon which holds approximately 0.1 gram of dust, a lump of coal, metal

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tray and hammer to crush coal, metal sieve and tray for screening coal, onionskin paper for diaphragm replacements, extra ignition filament coils, mop for cleaning lucite cylinder, and a brush for dusting the gallery.

Figure 3 is a detailed drawing of the gallery.

ASSEMBLING THE GALLERY

When assembling the gallery for a demonstration, it is impressive to obtain a lump of coal from a mine where the demonstration is to be performed, and, in view of the audience, break and pulverize the lump with the supplied accessories preparatory to the demonstration. The gallery should be at room temperature before a demonstration is attempted. It has been found that if the gallery is cold, good results will be uncertain, even though the filament is brought to the proper temperature and the proper amount of dust is used. This precaution is especially necessary in the ignition of coal dusts having a relatively low volatile-combustible ratio of approximately 0.18 or less.

To assemble the gallery, the resistance-filament assembly first should be plugged into place, making sure that the ignition coil is securely held by the two thumb nuts. The lucite cylinder, which acts as the explosion chamber, should be screwed onto its threaded connection, the toggle switch should be thrown to the left or "off" position, and the electric extension cord attached to a 110 or 115 volts a.c. supply. The aspirating bulb then is attached with rubber tubing to the nipple on the small dust chamber (in front of lucite cylinder). A paper diaphragm, consisting of two sheets of onionskin paper, is inserted between the two metal rings at the top of the lucite cylinder and held in place with two wing nuts. Before each test, the top sealing ring should be clean and free of coal dust before the paper diaphragm is fixed in position. It is important that the movable sealing ring be seated properly before tightening the wing nuts, to prevent cutting or shearing of the paper diaphragm before ignition.

To obtain a filament temperature of approximately 1,800° F., which is required to ignite coal dust in this gallery, first set the rheostat dial at the point marked "low" and throw the electric control switch to the right or "on" position. The rheostat then should be adjusted to the point at which the filament becomes a yellow-white color. After a few demonstrations, the operator can readily determine the correct color for ignition. If the require color of filament cannot be attained, it may be the fault of a low-voltage supply, and unless the voltage can be raised with a Variac or other suitable apparatus, a demonstration should not be attempted.

DEMONSTRATING WITH THE GALLERY

The screw cap is removed from the dust-holding chamber, and two level measuring caps of dust should be deposited in the chamber (approximately 0.1 gram in each level cap full). Precaution should be taken to replace the metal screw-cap chamber cover by screwing it securely into place, after which the lucite cylinder should be attached in its proper position. Next,

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Figure 1. - Coal-dust explosion gallery and accessories in specially designed carrying case.

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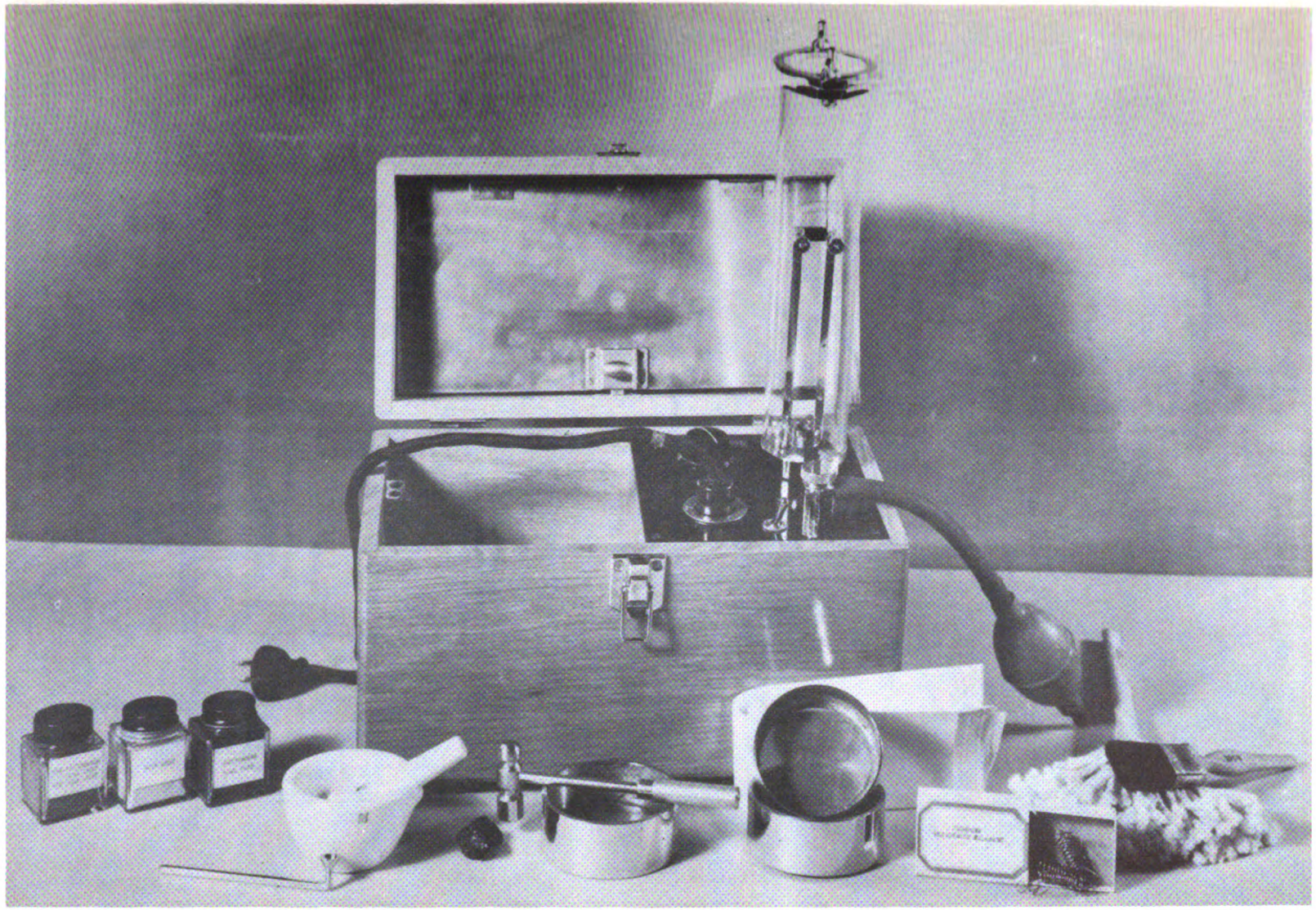

Figure 2. - Complete coal-dust explosion gallery assembled for demonstration.

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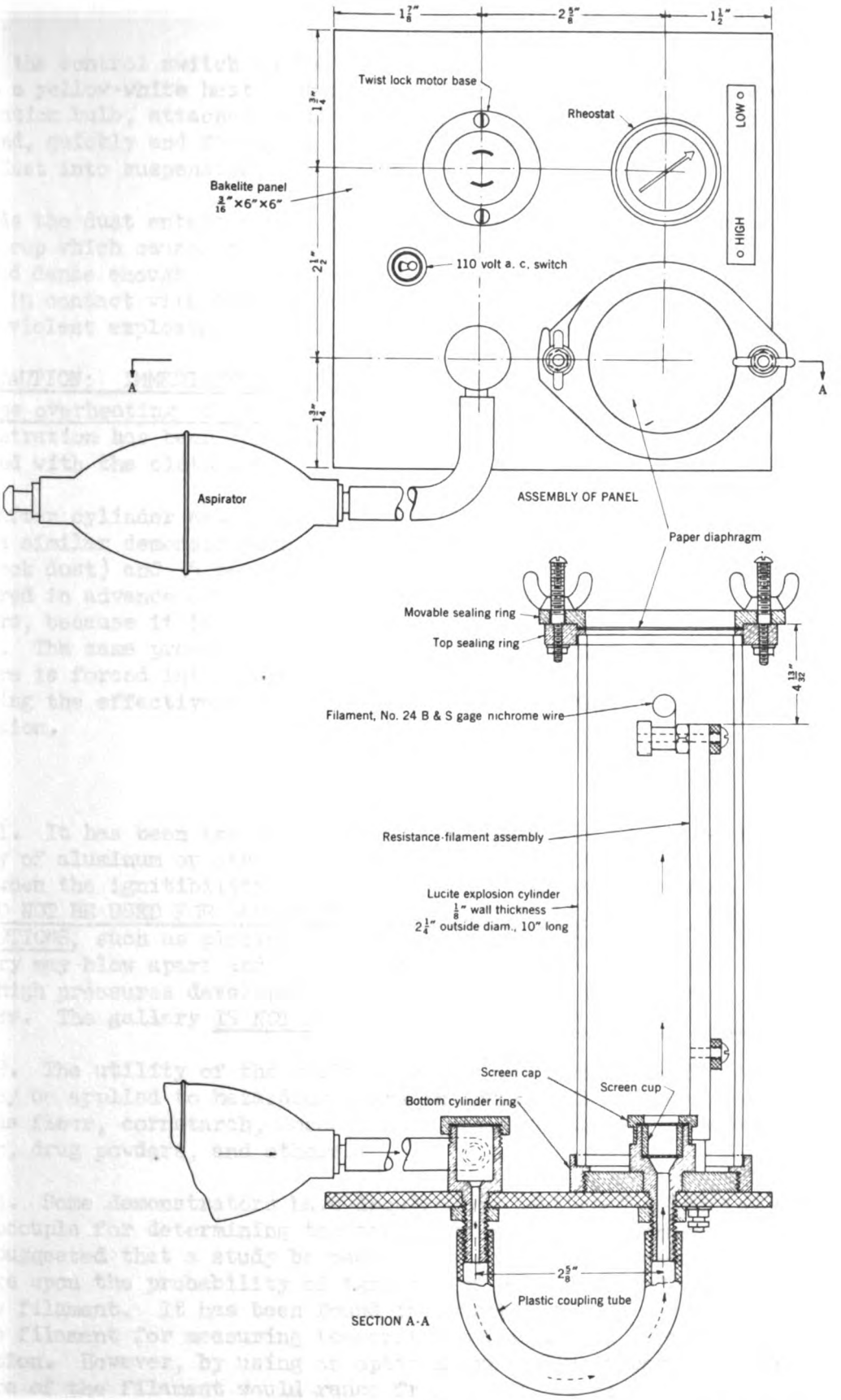

Figure 3. - Detailed drawing of coal-dust explosion gallery.

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throw the control switch to the "on" position and allow the filament to reach a yellow-white heat. When the filament reaches this temperature, the aspiration bulb, attached to the dust-holding chamber, should be compressed by hand, quickly and firmly; only one squeeze is necessary to force the coal dust into suspension.

As the dust enters the gallery, it passes through a screen-covered brass cup which causes the dust to pass up and over the heated filament in a cloud dense enough to be ignited readily. When the coal dust in suspension comes in contact with the heated filament, ignition of the dust can be seen, and a violent explosion will be heard as the paper diaphragm bursts.

CAUTION: IMMEDIATELY AFTER FIRING, the current should be turned off because overheating of the lucite tube will change its shape. After each demonstration has been completed, the lucite cylinder should be removed and cleaned with the cloth mop.

After cylinder and ring have been cleaned, the operator should proceed with a similar demonstration, using a mixture of 65 percent powdered limestone (or rock dust) and 35 percent coal dust by weight. The mixture should be prepared in advance of a demonstration engagement and carried in sample bottles or jars, because it is advisable to have the proper proportions of the two dusts. The same procedure is followed as with pure coal dust, but when this mixture is forced into suspension, ignition will not occur, thereby demonstrating the effectiveness of rock-dusting in preventing a coal-dust explosion.

REMARKS

1. It has been the practice in some districts to demonstrate the ignitibility of aluminum or other metallic and nonmetallic dusts or powders at the time when the ignitibility of coal dust is being demonstrated. THE GALLERY SHOULD NOT BE USED FOR DEMONSTRATING THE IGNITION OF THESE DUSTS WITHOUT EXTRA PRECAUTIONS, such as placing a heavy wire guard around the gallery. The gallery may blow apart and injure the demonstrator or audience because of the very high pressures developed by the explosion of some of these dusts or powders. The gallery IS NOT DESIGNED TO WITHSTAND SUCH PRESSURES.

2. The utility of the gallery is not confined to coal-dust demonstrations but may be applied to hazardous dusts in industrial and commercial plants, such as flour, cornstarch, cocoa, sugar, baking powder, sawdust, plastic powder, drug powders, and others.

3. Some demonstrators have inquired as to the advisability of using a thermocouple for determining the temperature of the filament. Also, it has been suggested that a study be made to determine the effect of the change of voltage upon the probability of ignition of coal dust and upon the temperature of the filament. It has been found inadvisable to use a thermocouple attached to the filament for measuring temperatures because of varying degrees of radiation. However, by using an optical pyrometer it was found that the temperature of the filament would range from 1,700° F. to 2,300° F. when the line voltage was raised from 80 to 120 volts a.c.

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